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UNITED STATES PATENT APPLICATION

of

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for:

PULL-OUT RESISTANT COMPRESSION FITTING FOR FLUID LINES

PULL-OUT RESISTANT COMPRESSION FITTING FOR FLUID LINES

FIELD OF THE INVENTION

The invention relates to fittings for connecting fluid supply lines, both gaseous and liquid, to various components in fluid handling apparatus.

BACKGROUND OF THE INVENTION

Connectors between fluid supply lines and fluid distribution circuits and fluid handling devices are common and varied, and are used in a wide range of industrial applications. Most such connectors must be secure and resistant to pull-out, since a failure of the connection resulting from pull-out can have disastrous consequences. Failures can result in uncontrolled release of contaminants and/or complete disruption and shut down of complex processes. This risk is heightened when the fluid handling system is robotically controlled, wherein additional stresses are imposed on the fittings resulting from movement of the robots, such as occurs, for example, in the electro-static application of paint in the automotive finishing industry.

Applying a finish coating to a vehicle involves supplying various fluids through various sizes of supply tubing at different stages of the process. The different

fluids may include paint, atomization air, air for air bearings, solvents, etc. In the painting process, different equipment components may require a plurality of supply lines for a single type of fluid, for example, different colors of paint may be required at a single painting station.

An atomizer may be supplied with several different tubes, differing both in size and material of construction, to control the flow of paint and the atomization of the paint, to maintain a desired paint pattern, to flush and clean the system and to provide a triggering mechanism for several pneumatic valves which may be employed throughout the system apparatus.

Herein, specific reference is made to a robotically controlled vehicle painting operation, a process which is particularly vulnerable to pull-out of supply lines at their respective connections into various component pieces of equipment used in this process. It is to be understood, however, that the pull-out resistant fitting of this invention may be useful in all applications where pull-out problems may arise and are to be avoided. Such wide-ranging applications are many and varied, and will be readily apparent to those skilled in the art.

Heretofore, compression fittings such as the fitting **10** depicted in Fig. 1 have been used to connect tubing **15** to such equipment. The compression fitting **10** of Fig. 1, further illustrated in the cross-section of Fig. 2 taken along line 2-2 of Fig. 1, includes a threaded fitting or nipple **12** which threadingly engages the fluid applicator component **18**, which may be a spray device, an atomizer, etc. The fitting **12** has hex-shaped section **17** which allows for wrench tightening and adjustment of the fitting into the component **18**. The fluid supply tube **15** is inserted into the proximal, upstream end of the fitting **12** and seats within the fitting at the flat **19**. Hex nut **14** is then tightened down on the upper threads of fitting **12**, compressing the nylon or other compression ring **16** into the tube **15** as shown in Fig. 2, and completing the compression seal between the inlet supply tube **15** and the bore **22** of the particular fluid handling component **18**. Such fittings are used, for example, to connect paint supply tubing to the inlet port of an atomizer or to a color change manifold.

Another type of known fitting is the push lock fitting **20** depicted in Fig. 1 and shown in cross-section in Fig. 3, which section is taken along line 3-3 of Fig. 1. A perspective view of the fitting itself, **20**, isolated, is shown in Fig. 4. In Figs. 1 and 3-4, the

fitting **20** includes external flange **26** and separated, insertable extensions **28** which are inserted into a tapered opening **32** in, e.g. a fluid handling manifold **18**, as seen in Fig. 3. The extensions **28** have ridges **36** molded therein which, upon insertion, expand to resist pull-out of the fitting **20**. A seal is effected by "O"-ring **30** which is compressed on insertion of the fitting, providing a seal between the inserted supply tube **24** and the bore **34** of the fluid handling manifold **18**. Such push lock fittings have been used to quickly connect or disconnect air supply tubing, for example.

Another type of hose connecting fitting is a twist-on fitting shown in Fig. 5. Fig. 5 is a simplified perspective view, partly in cross-section, showing a robot side base plate **42** attached to a robot arm (not shown), the plate **42** attached to a base plate **38** of a fluid handling device, e.g., a spray atomizer. Fluid, either gas or liquid, is fed through tube **15** which extends into the base plate **42** through opening **43** therein, and a twist-on fitting **44** is attached to the end of hose **15** by twisting, indicated by the arrow, with the tube **15** being secured therein by engagement with the internal threads **46** in the fitting **44**, the threads forming indented groove **50** in tube **15**. Inserted into the

fitting **44** are "O"-rings **48** as shown, such that, upon connection, the rings **48** form a seal between the supply tube **15** opening into the nipple **40** which extends from base plate **38**. The threads **46** provide some gripping force and resistance against pull-out. However, in such a connector, small threads offer limited pull-out resistance against the considerable forces exerted on the tubing during a spraying operation. Conversely, it is not practical to make the raised threads larger because that would allow the threads to cut into the tubing, both weakening it and making it difficult to assemble, the assembly being self-threading.

Compression fittings can be difficult to assemble and disassemble, especially in confined spaces. Push lock fittings are difficult to produce, owing to the complexity of the cavity and fitting, requiring special tooling. Neither is completely satisfactory in providing reliable and adequate resistance to pull-out. The present invention obviates difficulties inherent in prior art fittings.

SUMMARY OF THE INVENTION

A pull-out resistant connector assembly for connecting a fluid supply tube to a fluid handling device is provided. The assembly includes a connecting nut connected to a fitting, the nut and fitting securing the tube therebetween. The connecting nut has a proximal end and a distal end and has a first internal diameter extending lengthwise within the nut a first predetermined distance from the proximal end thereof, at which distance the internal diameter increases abruptly to a second, larger diameter extending longitudinally a further, second predetermined distance within the nut, thereby forming at the diameter transition an internal projection having a circumferential sharp-edged ridge within the nut at the first distance. The nut is connectable to and over the annular fitting, the fitting also having a proximal end and a distal end and having an internal bore therethrough and a longitudinally tapered external surface thereof. At its proximal end the fitting has an outside diameter such that the tube is slidable thereover, the fitting tapering along its length from the outside diameter at its proximal end thereof to a larger outside diameter, with this larger outside diameter extending longitudinally a distance along the length thereof, at which distance the outside diameter abruptly

decreases to a smaller diameter which extends longitudinally a further predetermined distance along the length of the fitting. An external projection having an external circumferential sharp-edged ridge is thereby formed around the fitting at the location of the abrupt diameter change.

The nut is adapted to receive a length of the fluid supply tube into and through its proximal end. Upon connection of the assembly, the tube extends within the nut a distance beyond the first predetermined distance, beyond the sharp-edged ridge in the nut, over the proximal end of the fitting, and extends along and over the fitting a distance beyond the external circumferential sharp-edged ridge thereof. On connection, the nut and fitting compress the tube therebetween and secure the supply tube thereat by the cooperative gripping forces exerted therearound by both sharp-edged ridges. The fitting is adapted at its distal end to connect the internal bore thereof to an inlet port of the fluid handling device.

The nut and fitting are preferably connected by internal threads in the nut mating with external threads on the fitting.

The projections in both the nut and the fitting are preferably tooth shaped in cross-section, and angled distally, thereby providing gripping or biting forces on the tube and resisting tube pull-out. In an alternate embodiment, the projections may each form a right angle.

The assembly is useful for connecting a plastic supply tube, such as a fluoroelastomeric supply tube, to a downstream fluid handling device. The assembly may be used to connect either gas or liquid supply tubes, such as air or paint supply tubes, and is especially suited to connect a plurality of fluid supply tubes to selected inlets in apparatus for spray painting automotive vehicles.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings,

Fig. 1 depicts two connectors known in the prior art for connecting fluid supply lines to a component of fluid handling apparatus, namely a compression fitting and a push lock fitting.

Fig 2. is a cross-sectional view of the compression fitting shown in Fig. 1 taken along line 2-2 of Fig. 1.

Fig. 3 is a cross-sectional view of the push lock fitting shown in Fig. 1 taken along line 3-3 of Fig. 1.

Fig. 4 is a perspective view of the conventional push fitting of Fig. 1.

Fig. 5 is a perspective view of a twist-on fitting known in the prior art, partially in cross-section.

Fig. 6 is a perspective view, partly in cross-section, of the pull-out resistant connector assembly of the invention connecting a supply tube to a fluid handling device.

Fig. 7 is an exploded perspective view of a wrench used to connect the assembly components of the invention to a supply tube.

Fig. 8 is an exploded view, partially in cross-section, of the connector assembly of the invention being assembled to connect a fluid supply tube to the nippled opening of a fluid handling device.

Fig. 9 is a schematic elevation, partly in cross-section, of one embodiment of the connector assembly of the invention.

Fig. 10 is a magnified cross-sectional view of a portion of a supply tube which is compressed and secured within the connector assembly of the invention.

Fig. 11 is a schematic elevation, partly in cross-section, of an alternate embodiment of a connector assembly according to the invention.

DETAILED DESCRIPTION OF THE INVENTION AND PREFERRED EMBODIMENTS WITH REFERENCE TO THE DRAWINGS

A pull-out resistant connector assembly for connecting a fluid supply tube to a fluid handling device is provided. The assembly includes a connecting nut connected to an annular fitting, the nut and fitting securing the tube therebetween. The connecting nut has, within it and extending therearound, a projection having an internal circumferential sharp-edged ridge. The nut is connectable to and over the annular fitting. At its proximal end the fitting has an outside diameter such that the tube is slidable thereover, and the fitting tapers along its length from the outside diameter at its proximal end thereof to a larger outside diameter at its distal end. The fitting has an external projection having an external, circumferential sharp-edged ridge formed therearound. The nut is adapted to receive a length of the fluid supply tube into and through its proximal end and, upon connection of the assembly, the nut and fitting compress the tube therebetween and secure the supply tube thereat by the gripping forces exerted therearound by the sharp-edged ridges. The fitting is adapted at its distal end to connect the internal bore thereof to an inlet port of the fluid handling device.

A more specific and detailed description of the invention and preferred embodiments is best provided with reference to the accompanying drawings wherein Fig. 6 depicts, in perspective and partially in cross-section, a preferred embodiment of the pull-out resistant fitting assembly according to the invention. Therein, a fluid supply tube **15**, such as a liquid paint supply line, or a line for supplying a gas (air), is connected to a component **38** of a fluid handling device, such as a spray atomizer, by a connector assembly of the invention. The connector assembly is shown extending through a robot-side base plate **42** affixed to plate **38** (such as by bolts, not shown), and includes a nut **52** connected to a fitting **54** by, in this embodiment, mating threads **56** on the nut and fitting. As shown, the fitting **54**, is sized so as to sealingly slide over the nipple **40** extending out of plate **38** and be sealed at its distal end in fluid-tight fashion by "O-rings **48**.

Nut **52** has a proximal, upstream end into which the tube **15** is inserted. This proximal inside diameter of the nut **52** is somewhat larger than the outside diameter of tube **15**, so that slidable insertion of the tube into the nut is easily accomplished.

By definition herein and for ease of reference, the term proximal will denote an upstream location or end of a given component and the term distal will, accordingly, denote a downstream location or end of that part, wherein upstream and downstream both refer to the direction of flow of the fluid being supplied.

The nut **52** has an inside diameter (I.D.) at its proximal end **58** which is larger than tube **15** to permit insertion therein. This I.D. **58** extends longitudinally within nut **52** a first predetermined distance, at which distance the I.D. of the nut increases abruptly to a larger I.D. **62**, forming an internal circumferential projection **82** at the transition distance, which projection (**82**) will be described fully below. The larger I.D. **62** of the nut **52** extends a further, second predetermined longitudinal distance into the nut as shown in the figure.

The fitting **54**, shown in this embodiment threadingly mated with nut **52** by threads **56**, extends from a proximal tapered entry **64** to central bore **65** which is in sealed fluid communication with the nipple **40** affixed to and connected to fluid handling device **38**. The annular fitting **54** has a tapered external surface longitudinally thereof as shown in Fig. 6. The outside diameter (O.D.) **66** of the fitting at the proximal end is such that tube

15 is slidable thereover. The O.D. 66 of the fitting extends longitudinally an initial length as shown in Fig. 6 and then tapers outwardly along a tapered length 68 to a somewhat larger outside diameter 70, at which distance the fitting's outside diameter abruptly decreases to O.D. 71, which then continues essentially to the external threads 56 of the fitting 54. When connected, by the threads 56 in the embodiment shown, the tube 15 is inserted into the nut 52 a substantial distance and the proximal end of the fitting 54 is inserted into the end of the tube 15. The fitting is then tightened down such that the tube is forced over the external surface thereof, over the proximal O.D. 66 of the fitting, over the taper 68 and over the larger O.D. 70 of the fitting, extending over the projection 84 (described below), the fitting 54 and the nut 52 compressing the tube 15 within and between the nut and the fitting. The entire assembly may be held together by bolts (not shown) which affix the robot side base plate 42 to the fluid handling component 38.

In a typical fluid handling (e.g., spray painting) operation, the tube 15 may be a plastic tube such as a fluoroelastomeric tube, which is inert to most fluids. The nut 52 and the fitting 54 may be of any suitable material, plastic or metal, and may include polyacetals

or polycarbonates, or steel or stainless steel, for particular applications. Fluid handling components, "O"-rings, and auxiliary attachment components are conventional. Materials of construction for a particular application will be a matter of design choice.

Fig. 7 illustrates a tool useful in the installation of the connector assembly of the invention. Therein, tube **15** is shown extending into nut **52**, which has external indents **78** positioned around the proximal end thereof. The nut **52** is threadable onto the fitting **54**, as indicated by the arrows. In this figure, the proximal O.D. **66**, the tapering surface **68**, and the distal O.D.'s **70** and **71** of the fitting **54**, over which the tube **15** slidingly engages the fitting, are more clearly seen. The flats **55** permit a wrench to grip and tighten the fitting. To do so, a wrench (not shown) first secures the fitting **54**. The tool, having split body **72** with slot **74** to accommodate the tube, then engages the indents **78** in the nut **52** by means of detents **76** and the nut and fitting are tightened down by turning handles **80** while holding the wrench.

The procedure for assembly of the fitting is further illustrated in Fig. 8. Having inserted the tube **15** through the opening **43** in the backing plate **42**, and exposing the end of the tube, the tube **15** is inserted

into the nut **52** as shown. The proximal end of the fitting **54** is inserted into the end of the tube, and the fitting and nut are tightened down to force the tube **15** to slide over the external surfaces **66, 68, 70** and **71** of the fitting **54** and be compressed as shown between the fitting **54** and the nut **52**. The assembly is completed by slidably engaging the fitting **54** over the nipple **40** and securing the base plate **42** to the component **38** of the fluid handling apparatus, e.g., by bolts, not shown.

A key to the pull-out resistant fitting of the invention is illustrated in more detail in Figs. 9 and 10. Fig. 9 shows the completed fitting and nut assembly and the circumferential projections **82** and **84**, both having sharp-edged ridges as shown, which act as cooperating gripping means to resist and prevent the tube **15** from pulling out of the connector assembly, even on application of sizable pull-out forces. The proximal I.D. **58** of the nut **52** extends along the nut for the aforesaid first distance to an abrupt change, to larger I.D. **62**, whereat the projection **82** is formed having the sharp edge shown which bites into and grips the tube **15** upon assembly of the connection. Cooperatively, the fitting **54** extends within the nut **52** causing the tube **15** to be forced over its external proximal O.D. **66**, over the taper **68** and over the larger O.D. **70** thereof, at which

point the fitting outside diameter **70** abruptly decreases to O.D. **71**, thereby forming the projection **84** having its sharp-edged ridge as shown extending circumferentially around the tube and gripping it.

A magnified view of both projections **82** and **84** is shown in Fig. 10. Therein, fitting **54** extends into nut **52**, and tube **15** is compressed in the gap between the nut **52** and fitting **54**. The tube extends over the taper **68** of the fitting and over the larger O.D. **70** of the fitting to the point whereat the fitting outside diameter abruptly decreases to O.D. **71** as shown, thereby forming the circumferential projection **84** having its sharp-edged ridge as shown.

The proximal inside diameter **58** of the nut **52** abruptly increases to the I.D. **62** illustrated in Fig. 10, thereby forming the projection **82** at the transition. The two projections **82**, **84**, which are shown to be tooth shaped in the figures, a preferred configuration, act cooperatively to restrain the tube **15** against pull-out. These tooth-shaped projections **82**, **84** are also preferably angled distally, as also illustrated in Figs. 9 and 10, to further enhance the biting forces and restrain pull-out.

Fig. 11 illustrates an alternate embodiment of the invention wherein the projection **86** forms a right-angled sharp step for gripping and retaining tube **15**. This embodiment may be useful in certain applications,

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While the invention has been disclosed herein in connection with certain embodiments and detailed descriptions, it will be clear to one skilled in the art that modifications or variations of such details can be made without deviating from the gist of this invention, and such modifications or variations are considered to be within the scope of the claims hereinbelow.